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**Anaerobic Digestion (AD) of:
Grease Trap Waste (FOG)
Animal Waste (Manure)
POTW Waste Streams**

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A Four Part Presentation:

1. AD Basics

**2. Comparison of FOG, Manure and POTW
AD Systems**

**3. AD Applications in the US; and in
Kansas**

4. Summary of Key Concepts

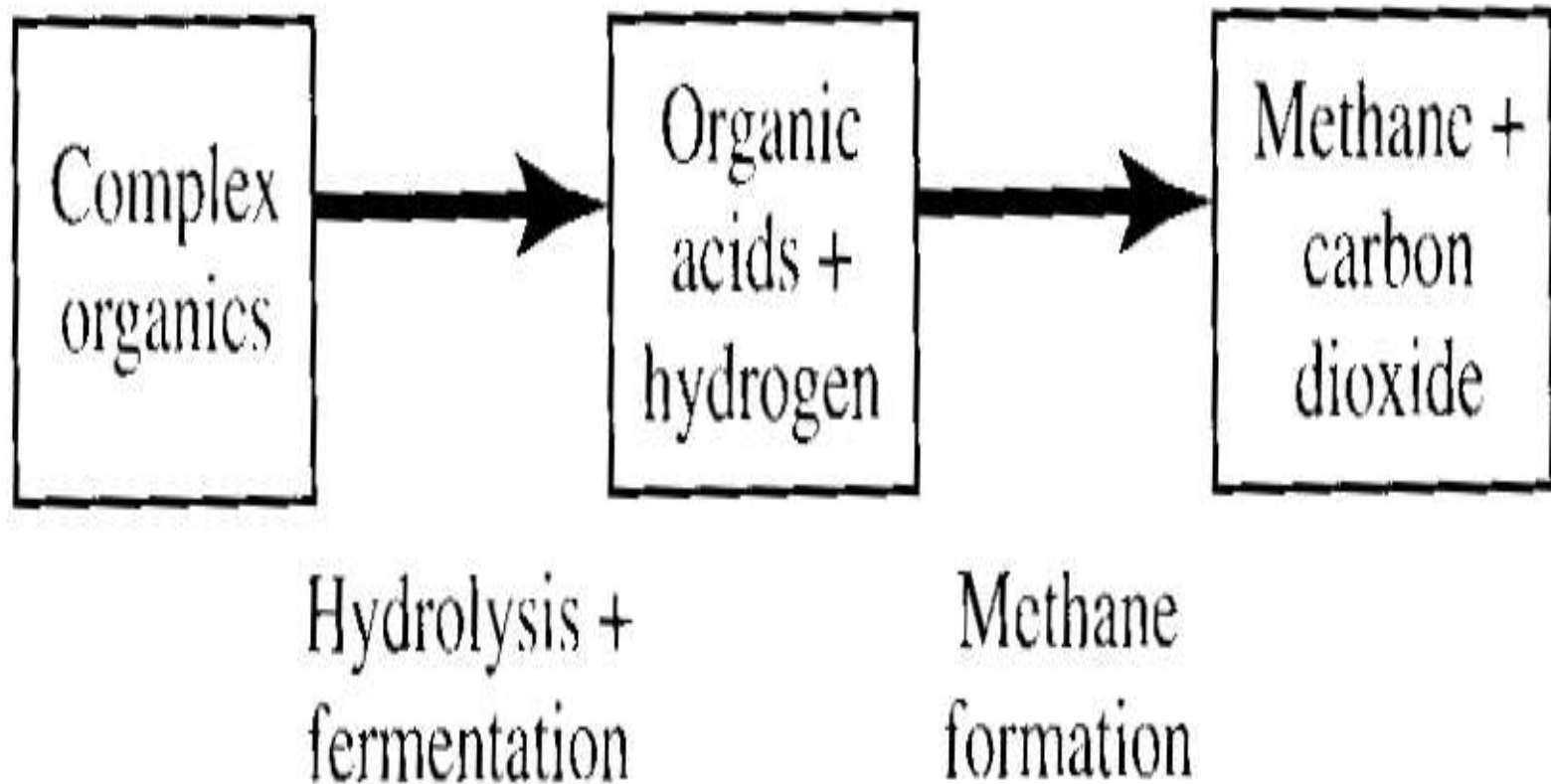
Part 1: What is AD?

Definition: AD is a microbically mediated process that converts organic matter **in a liquid medium**^{*} into a gas (and other end products) known as biogas; which is principally composed of methane (CH₄) and carbon dioxide (CO₂).

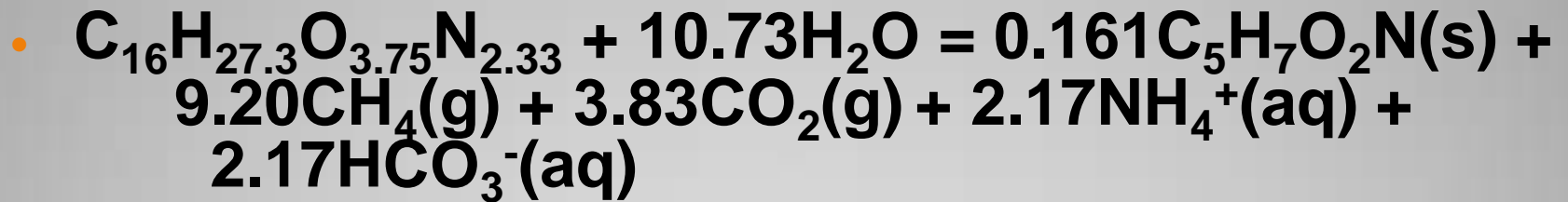
^{*}Versus dry digestion: See BIOFerm[®] pamphlet.

Very simply, AD is a two step process which involves two groups of microbes: acid and methane formers.

Rittman and McCarty (2001)



A detailed equation for AD: Rittman and McCarty (2001)



- Where:
- $\text{C}_{16}\text{H}_{27.3}\text{O}_{3.75}\text{N}_{2.33}$ is the source of organic matter
- H_2O = moisture requirement for the reaction to occur.
- $\text{C}_5\text{H}_7\text{O}_2\text{N}$ = microbial solids by-product
- CH_4 = desirable gaseous by-product
- CO_2 = undesirable gaseous by-product
- NH_4^+ = liquid by-product
- HCO_3^- = liquid by-product

What are the potential benefits of AD?

(Ross McKinney, KU Distinguished Emeritus Professor, said ca 1962, “Anaerobic digestion is the pot of gold at the end of the rainbow.” Here’s why:)

- 1. Methane a valuable energy source.**
- 2. Pathogens in manure and POTW wastes are reduced.**
- 3. Resultant liquid and solids may be useful.**
- 4. High organic loading possible.**
- 5. Low nutrient requirements.**

What are the negatives of AD?

- 1. Growth rate temperature dependent.**
- 2. May require pH control.**
- 3. Microbes are vulnerable to toxics.**
- 4. Odorous, poisonous, corrosive and erosive gases (H_2S and siloxanes*); and explosive CH_4 produced.**
- 5. End products (microbial solids and ammonium) may require further treatment.**

***Common to MSW; not FOG, manure or POTW.**

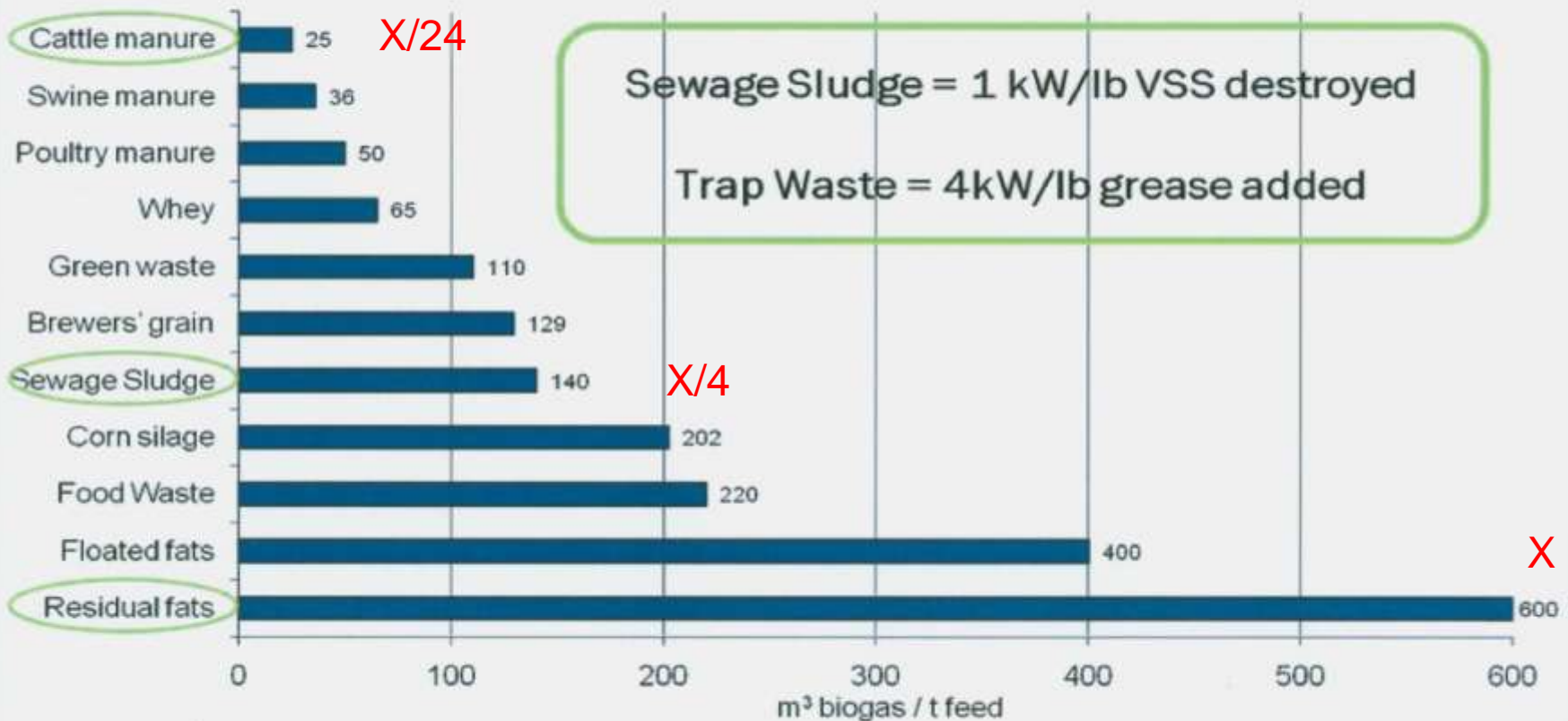
Why is all this important?

Because something considered to be a waste and will cost money can be used to make money and make the environment better.

Part 2: Comparison of FOG, Manure and POTW AD Waste Systems

- These **wastes** can exist as solids or liquids, e.g., FOG oils are liquid but greases are solids.
- However, **all AD wet digestion systems** require liquid regimes to occur.

Feedstock Comparisons



■ Lusk, Philip D (2005). Establishing Credibility. PowerPoint presentation given at Fifth Annual BioCycle Conference on Renewable Energy From Organics Recycling, September 2005, Madison, Wisconsin.

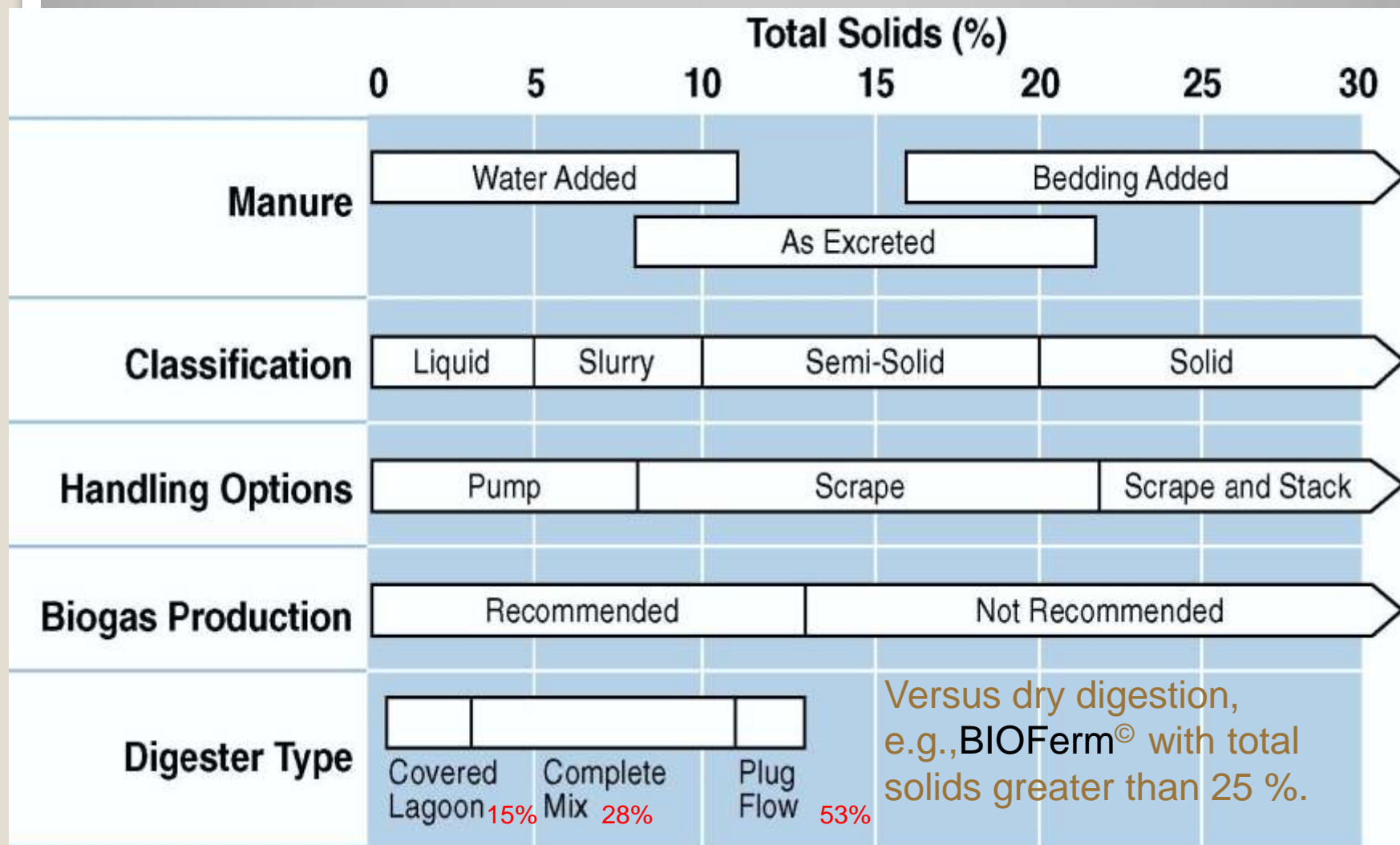
Typical Manure Solids Content AgSTAR Handbook

Animal Type	Total Solids (%)*
Swine	9.2 – 10.0
Beef	11.6 – 13.0
Dairy	11.6 – 12.5
Poultry (Caged Layers)	25

*Versus 2.5 to 15 % in primary and secondary POTW sludges

Manure AD Options and Solids Content

AgSTAR Handbook (2004) and OSU (2011)

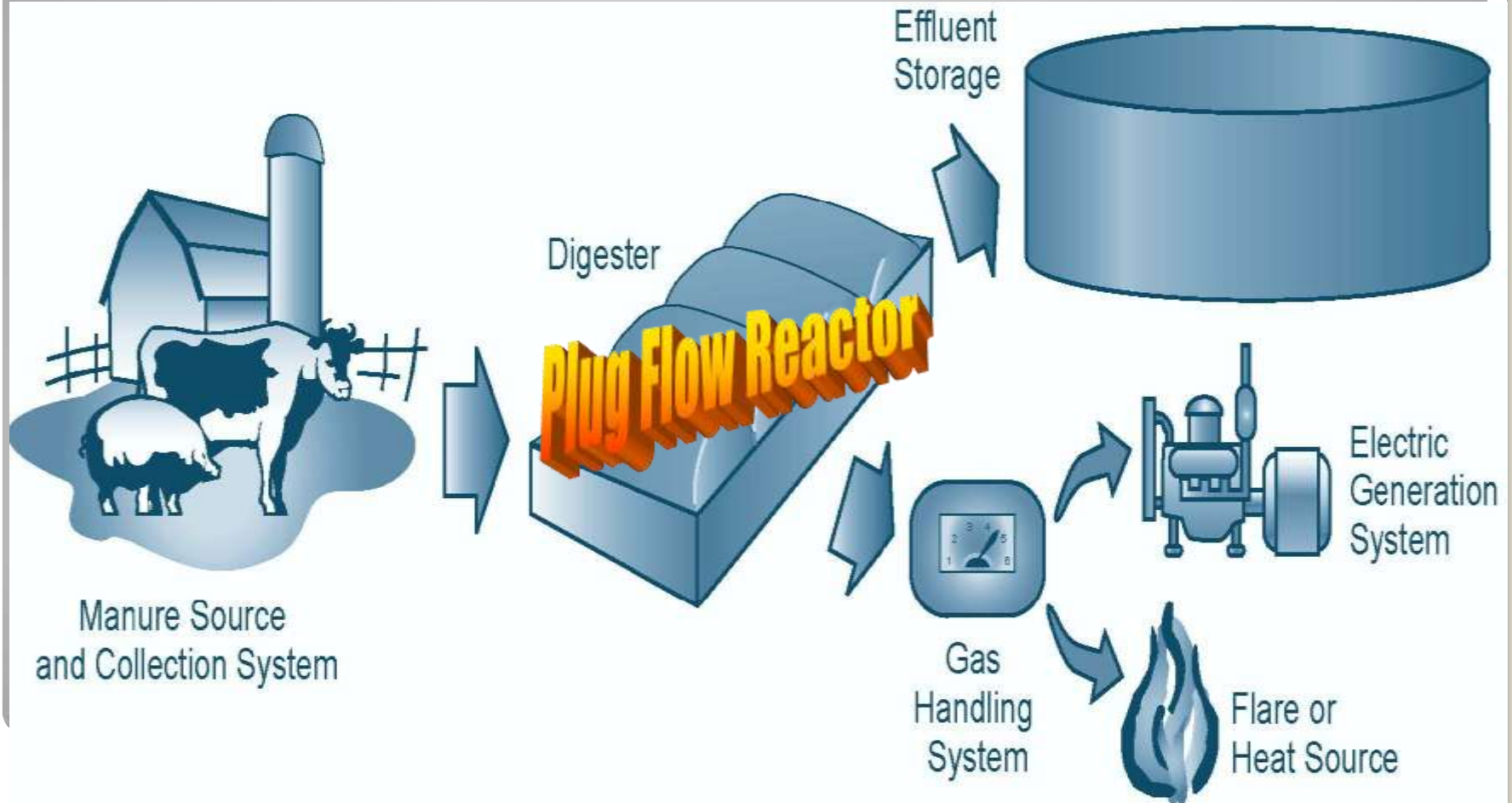


Manure AD Systems: Typical Design Considerations

Agstar Handbook

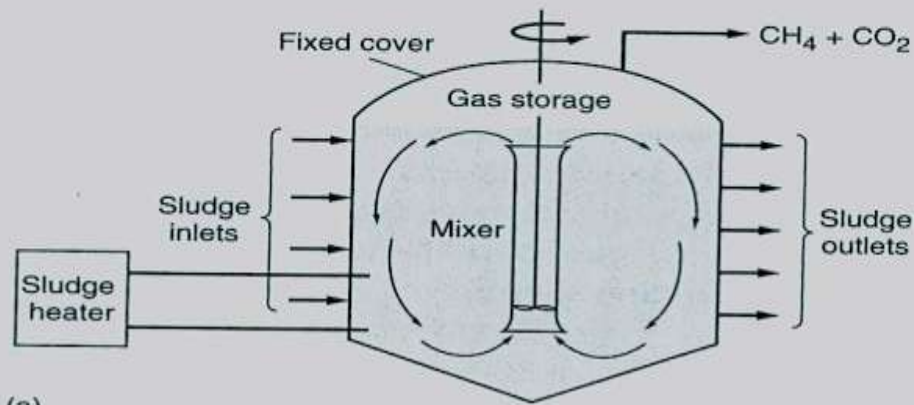
Item	Lagoon	Mixed	Plug Flow	Fixed Film
Container	Earthen	Tank	Tank	Tank
Tech Level	Low	Medium	Low	Medium
Heated	No	Yes	Yes	No
% Solids	0.5 – 3	3 – 10	11-13	3
Type Solids	Fine	Coarse	Coarse	Very Fine
HRT (days)	40 – 60	15+	15+	2 -3
Climate	Temperate and Warm	All	All	Temperate and Warm

Typical Manure AD Facilities AgSTAR Program

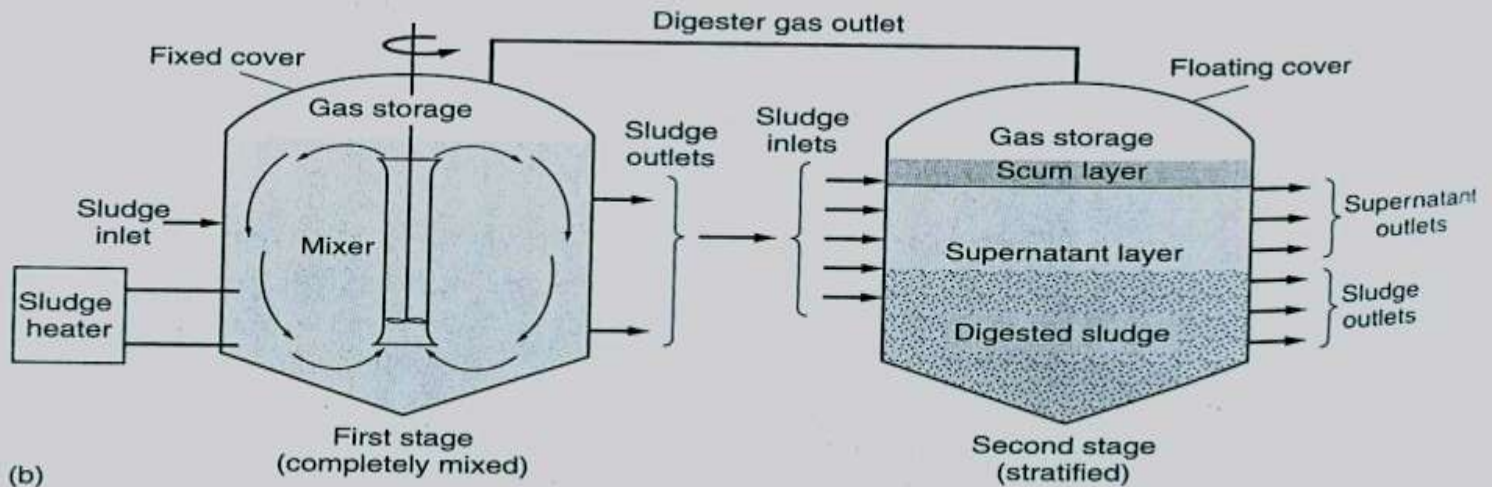


Mixed AD Systems

Metcalf & Eddy (2003)

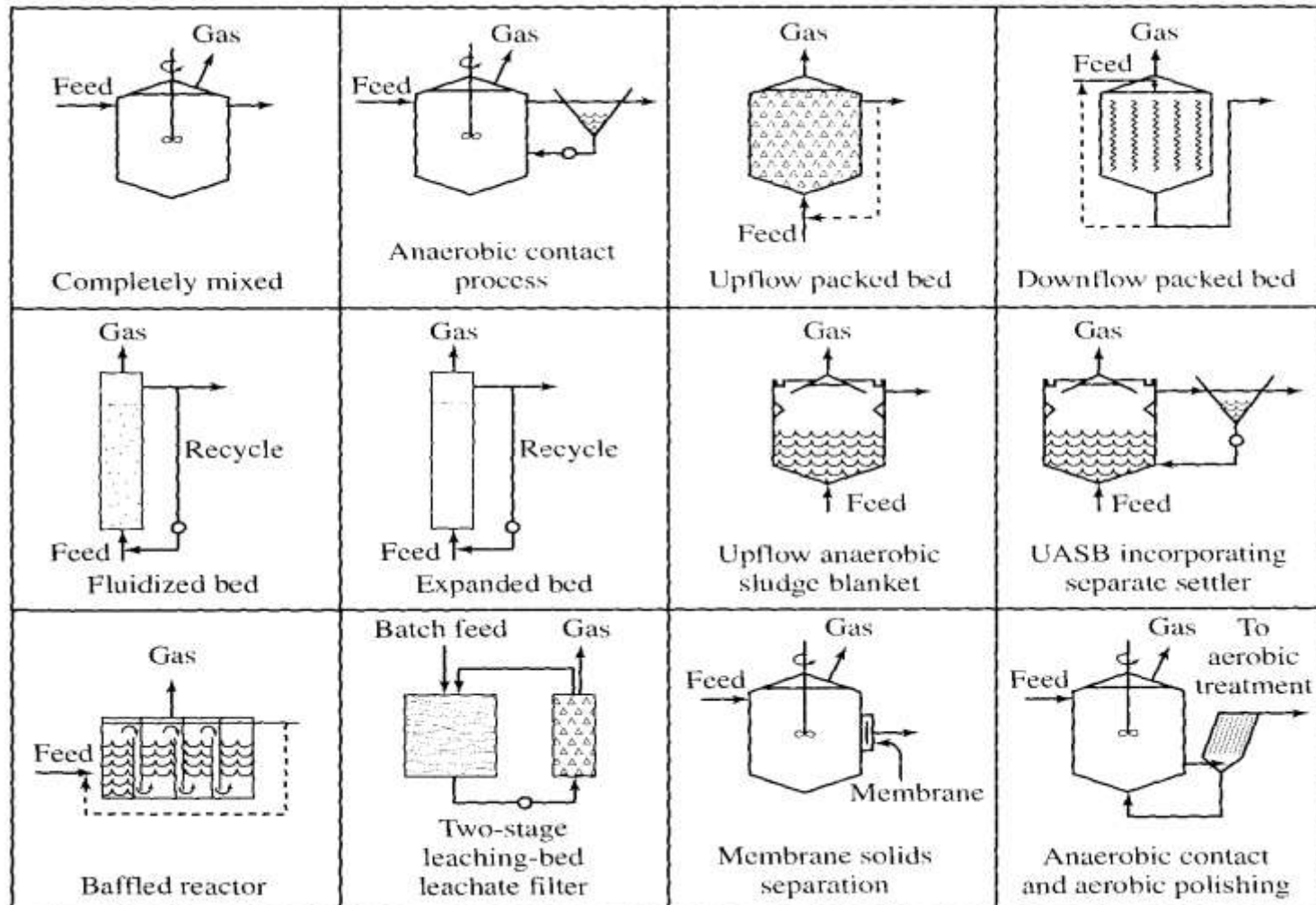


(a)



(b)

AD Reactor Types



Part 3: AD Applications in US: Activities are increasing nationally.

1. A review of AD listings in BioCycle magazine since 2003 showed 61 articles (7 FOG, 31 manure and 2 sludge). Also, there is now regular AD coverage starting in the February 2011 issue.

160 AD Manure Projects (November 2010) in 33 states: 153 Dairy, 24 Swine, 5 Poultry and 2 Beef.

Agstar Program



2. Last year's 10th Annual BioCycle Conference had two days of three concurrent sessions; many dealing with AD of organic wastes.

AD Applications in Kansas:

3. According to KDHE BOW staff:

FOG: Johnson County **will have a FOG receiving facility at the DLS Middle Basin POTW and Topeka has one at the Oakland plant. No attempt was made to see how other cities are handling FOG wastes.**

Also, a pre-cooked bacon company in Pittsburg has a FOG recovery process.

CAFO: **There are no AD operations.**

POTW: There about 20 municipal sludge AD plants; but, only Johnson County has any extra-process energy recovery systems. However, AD has found its greatest application as a pretreatment process prior to final aerobic treatment of high strength industrial wastes. The number of facilities is unknown.

Part 4: Summary of Key AD Process Requirements:

- 1. Biodegradable organics required.**
- 2. Smaller sized solids preferred.**
- 3. Need low solids concentration for flow.**
- 4. Need nutrients for microbial growth.**
- 5. Mixing capability required to enhance digestion.**

Key AD Process Requirements (Continued):

- 6. Higher temperatures speed up reactions.**
- 7. Solids separation may be required after digestion.**
- 8. Gas purification may be required after gas collection.**
- 9. Odorous, explosive and corrosive gases to potential problems.**
- 10. Higher operator skills required.**

Economics are the key for AD success:

Current and future economics will determine if the AD process will be successful, i.e., competitive markets must exist for AD end products which exceed the RD&D, capital and operating costs for each type of waste situation and system.

Care must be taken to define each of these considerations or AD can be boondoggle instead of a boon. A capable consultant is needed to determine which result you will obtain.

Comments or Questions

- Contact me at:
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- Or, give me your business card with your e-mail address.